I Claim:

1. A carrier recovery apparatus for a received intradyne signal that is phase shift keyed in N steps, where N is a phase step number, comprising:

an input for receiving a received intradyne signal;

a frequency multiplier for multiplying a frequency of the received intradyne signal by a factor of N, and thereby generating a frequency-multiplied intradyne signal;

a filter connected to said frequency multiplier, said filter filtering the frequency-multiplied intradyne signal to generate a filtered frequency-multiplied intradyne signal; and

an intradyne frequency divider connected to said filter, said intradyne frequency divider dividing the frequency of the filtered frequency-multiplied intradyne signal by a factor of N, thereby generating a carrier intradyne signal from the filtered frequency-multiplied intradyne signal, and said intradyne frequency divider undertaking more than one state change while changing a phase of the carrier intradyne signal by $2\pi/N$.

2. The apparatus according to claim 1, wherein said intradyne frequency divider comprises:

a multi-frequency oscillator for generating a fundamental-frequency intradyne signal derivative having a fundamental frequency and a harmonic-frequency signal with a harmonic frequency being an N-fold multiple of the fundamental frequency;

a mixing unit for processing the filtered frequency-multiplied intradyne signal and the harmonic-frequency signal to generate a scalar product in which the frequency of the filtered frequency-multiplied intradyne signal has been translated by the N-fold of the fundamental frequency, wherein an absolute value of the fundamental frequency is so large that a scalar product can represent the filtered frequency-multiplied intradyne signal without loss of information;

a state machine, to which said scalar product is directed, said state machine dividing the frequency of the scalar product by N, thereby generating a frequency offset carrier signal; and

a multiplying unit for mixing the fundamental-frequency intradyne signal derivative and the frequency offset carrier signal, where the frequency of the frequency offset carrier

signal is translated back by an amount equal to the fundamental frequency, thereby generating a carrier intradyne signal.

3. The apparatus according to claim 1, wherein said intradyne frequency divider comprises at least one regenerative intradyne frequency divider.

4. The apparatus according to claim 3, wherein a regenerative intradyne frequency divider comprises:

a complex multiplier for multiplying an intradyne input signal of said intradyne frequency divider and a complex conjugate intradyne signal; and

a complex conjugator for subjecting the intradyne output signal of said complex multiplier to a complex conjugation before it is being fed back as a complex conjugate intradyne signal to said complex multiplier.

5. The apparatus according to claim 3, wherein a regenerative intradyne frequency divider comprises:

a complex multiplier for multiplying an intradyne input signal of said intradyne frequency divider and a complex conjugate intradyne signal; and

a complex conjugator and a power raising unit cascaded with said complex conjugator in arbitrary order, wherein the intradyne output signal of said complex multiplier undergoes complex conjugation and is raised to a W-th power, W being a positive integer, before being fed back as a complex conjugate intradyne signal to said complex multiplier.

6.   A carrier recovery method for a received intradyne signal that is phase shift keyed in N steps, where N is a phase step number, which comprises:

multiplying a frequency of the received intradyne signal by a factor N, thereby generating a frequency-multiplied intradyne signal from the received intradyne signal;

filtering the frequency-multiplied intradyne signal; and

dividing the frequency of the filtered frequency-multiplied intradyne signal by a factor N in an intradyne frequency divider, thereby generating a carrier intradyne signal from the filtered frequency-multiplied intradyne signal, in which process said intradyne frequency divider undertakes more than one state change while changing a phase of the carrier intradyne signal by $2\pi/N$.

7.   The method according to claim 6, which comprises:

generating a fundamental-frequency intradyne signal derivative having a fundamental frequency and a harmonic-frequency signal with a harmonic frequency, the harmonic frequency being an N-fold multiple of the fundamental frequency;

processing the filtered frequency-multiplied intradyne signal and the harmonic-frequency signal to generate a scalar product in which the frequency of the filtered frequency-multiplied intradyne signal has been translated by the N-fold of the fundamental frequency, wherein an absolute value of the fundamental frequency is so large that the scalar product can represent the filtered frequency-multiplied intradyne signal without loss of information;

dividing the frequency of the scalar product by N, thereby generating a frequency offset carrier signal; and

mixing the fundamental-frequency intradyne signal derivative and the frequency offset carrier signal, so that the frequency of said frequency offset carrier signal is translated back by an amount equal to the fundamental frequency, thereby generating a carrier intradyne signal.

8.   The method according to claim 6, which comprises carrying out regenerative intradyne frequency dividing.

9. The method according to claim 8, which comprises:

complex-multiplying an intradyne input signal, the frequency
of which is to be regeneratively divided, and a complex
conjugate intradyne signal; and

complex-conjugating the regeneratively frequency divided
intradyne signal to generate the complex conjugate intradyne
signal.

10. The method according to claim 8, which comprises:

complex-multiplying an intradyne input signal, the frequency
of which is to be regeneratively divided, and a complex
conjugate intradyne signal; and

complex-conjugating and raising to a W-th power, W being a
positive integer, of the regeneratively frequency divided
intradyne signal to generate the complex conjugate intradyne
signal.